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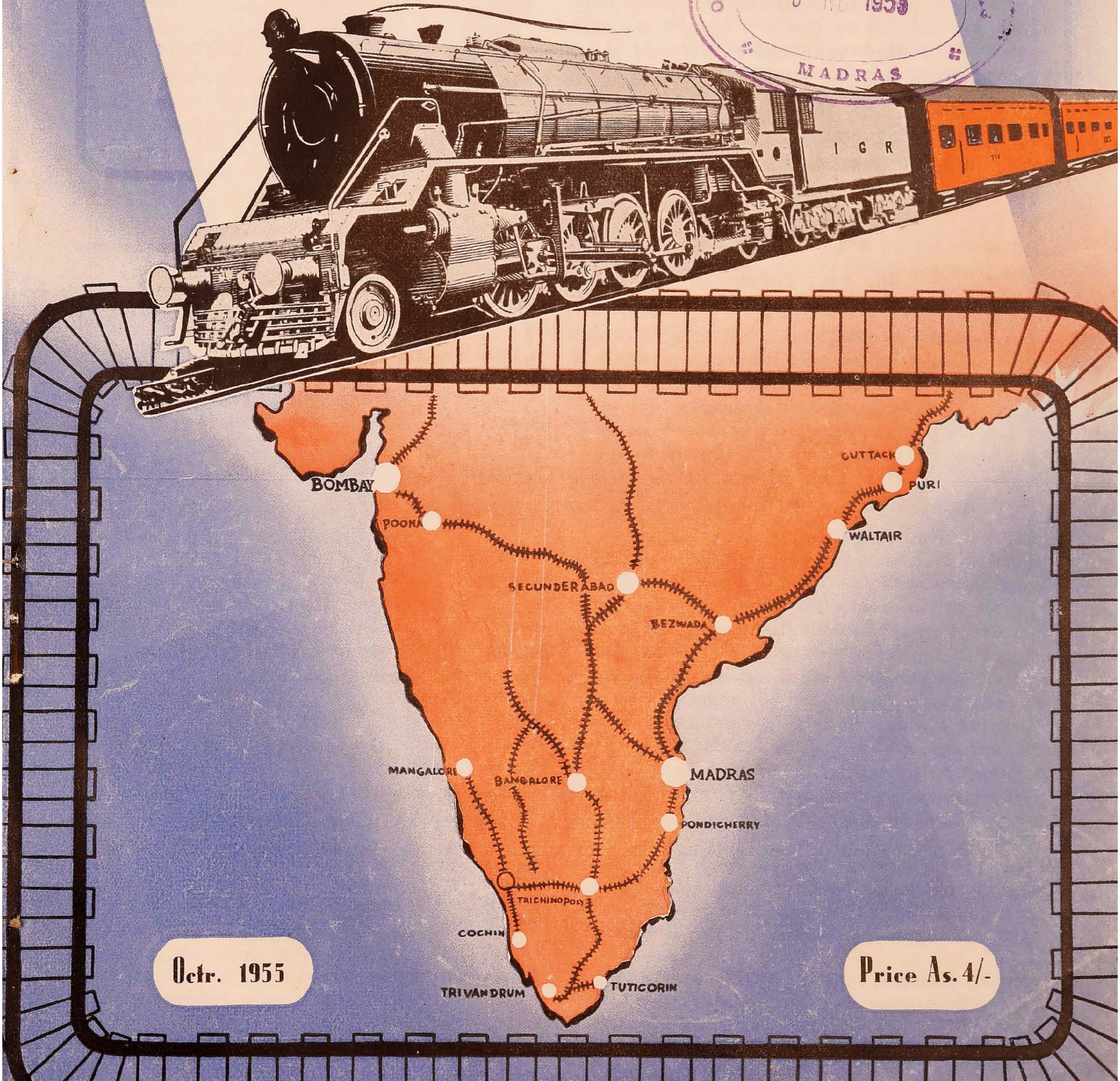

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(Inserted in the interests of Travelling Public)

Sand/Shot blasting—its application in railways and recent developments

By A. C. Bhattacharya, A.M.I. Prod. E.

SPEED is the essence of modern life - the quicker the job, the lower the costs and nowhere more than on the railways is this of such vital importance. For obscuring glass panes of lavatory windows of railway carriages, for cleaning iron and steel castings, for removing scale from steel sections as well as rust from all types of steel structures and for a multitude of other similar purposes, sand blast is the only satisfactory answer to this problem. Though primarily employed by the glass industry, it has in the course of time conquered many other fields of application and now constitutes one of the many mechanical aids of outstanding merit available to the workshop engineer.

EARLY HISTORY

The sand blast process came into being as a result of noticing the matting effect of sand storms upon the glass windows of a house on an American prairie, and in about 1870, Gen. B.C. Tilghman of Philadelphia first applied it to practical purposes and took out the original patent for sand blast machines. Tilghman's sand-blast consisted of a contrivance for impelling, with graduated degrees of velocity, a jet or column of sand by a blast artificially produced (of steam in some cases, of air in others) against the object or surface to be acted on. The operation excited great interest when shown in the London International Exhibition of 1873.

The process was first applied to obscure, engrave and ornament glass, and later, to carve deep patterns in granite, marble, and other hard stones, to bite into steel, dress and sharpen files and even to cut and perforate holes through these and other most refractory materials. In 1875 inscriptions were cut by means of the blast on 150,000 tombstones of soldiers killed in the American Civil War. Cast iron letters were fastened by shellac on the marble the sand was driven by steam pressure of 90 lbs. and the stone was cut in 4 minutes, to a depth of a $\frac{1}{4}$ inch, leaving the letters in relief.

While the use of steam for producing the blast was considered most simple and economical, many practical difficulties arose in its employment and consequently for obtaining high pressure of air, costly apparatus was required, thus limiting the applications of the agency. In 1884, Mr. Mathewson patented an apparatus in which, by an ingenious exhaust arrangement, the impelling steam was swept away, leaving only cool, dry sand to strike against the object acted on.

It is however to be noted that the particles of sand will cut only hard substances but not soft ones—a result due to the fact that each particle makes a minute cavity at once by direct impact when the receiving surface is hard, whereas a softer substance acts as a buffer or elastic rebounding cushion. A plate of glass covered with wire gauze may, by the action of the jet, be pierced and converted into glass-gauze — a curious effect obtainable by no other means.

SHOT BLAST

Owing to the danger to health in the use of sand, it was gradually superseded by chilled iron shot, grit or Blastyte. Sand is now prohibited as an abrasive except in a wet state and is used for items of jewellery, silver plate and similar articles. Further research with these abrasive opened up new avenues and with the use of iron shot in a large number of cases, the term sand blast has now been replaced by shot blast which is now used for many other special operations, in addition to all the original processes which are constantly being improved.

ITS VARIOUS USES IN RAILWAYS

The most important field of application for the shot blast is in metal working departments of the railway workshops, where laborious and disagreeable manual work has to a large extent been replaced by work with shot blast. In the Smith's shop, for example, shot blast is being used for cleaning drop stampings, forgings and billets, etc., with amazing speed and efficiency. Similarly modern foundries use the shot blast extensively for cleaning their castings. This work is done so thoroughly, both on the outside and the inside of the castings, that all the troubles previously experienced from imperfectly cleaned pieces, e. g. blunted cutting tools due to sandy spots, leaks which escaped notice during inspection, etc., have completely disappeared. This thoroughness has been due to the fact that shot blast reaches the remotest corners unapproachable by hand. Steel castings, which often show spots of burnt-in moulding sand, can be cleaned economically only with shot blast.

In affording the most effective preparation for every kind of surface treatment, such as galvanising, nickel

plating, enamelling, and so on, shot blast plays no less important part. The advantage of shot blasting in such cases is that by controlling the type of abrasive and the pressure of the blast, the surface of the metal can be "Keyed" in preparation for subsequent finishing.

Shot Blast is also used with advantage to remove the oxide skin and other kinds of scale from metal sheets and other rolling mill products and has in this respect replaced the old-style process of pickling in the acid bath. The coat of paint applied to shot blasted sheets shows no tendency to blister as in the case of pickled sheets, where traces of the acid are liable to survive behind rolled-in slag particles in spite of most conscientious neutralizing with milk of lime. It is for this reason that locomotive boilers and panel plates of carriages are cleaned with shot blast.

In bonding rubber to metal, the surfaces are generally prepared by shot blasting before gluing with the compound. The life of a file, an indispensable tool of frequent use in all workshops can be multiplied many times and efficiency greatly increased by cleaning and then regular sharpening with sand blast.

In view of these manifold uses developing in the course of many years, many different types of sand / shot blasting machines have been evolved to enable the various kinds of work to be carried out to greatest perfection and in the most economical way.

SHOT BLAST ROOM

Among the different types of sand / shot blasting equipment available, the shot blast room is a convenient method of treating a wide variety of relatively heavy parts. It allows close proximity of the operator to work with the resultant advantage of dealing with intricate parts.

A complete standard shot blast room installation generally comprises :–

(a) Shot blast room or operating chamber with the collecting hoppers.

(b) Automatic abrasive conveyor and bucket elevator for the return of the abrasive material to the shot blast apparatus.

(c) Automatic rotary screen and dust separator, the dust being taken away from the abrasive by means of the main exhauster.

(d) Dust arrester for removing the dust before the exhaust air is discharged to the atmosphere.

(e) Exhauster for ventilating the room.

(f) Complete air compressing plant consisting of electrically driven air compressor, after cooler and air receiver.

Until early thirties the abrasive and dust were separated by means of what was known as suction system. In this system the spent abrasive used to pass by gravity through steel perforated grids forming the floor of the room to the bucket elevator for re-use and the dust was also drawn away by the exhaust system through the floor. The process was however found to be both less efficient and uneconomical in as much as for an effective displacement of the atmosphere of the room, the dust-laden atmosphere had to be exhausted for not less than five times per minute.

The system had to be discarded therefore in favour of direct pressure system incorporating the use of pressure chamber, fitted with abrasive and air mixing tube at base. During the process of blasting, both the pressure chamber and the air mixing tube are under equal pressure and the abrasive falls into the mixing tube by gravity. The abrasive entering the mixing tube is projected through the flexible rubber blast pipe and nozzle. To ensure clean abrasive being used during every cycle of operation, an apparatus known as automatic rotary screen and dust separator is used above the pressure chamber. This pressure unit now forms the basis of the more efficient and automatic shot blasting equipments of to-day, in all of which it is incorporated.

The shot blast room is composed of a strongly fabricated frame made from angle and tee sections and is enclosed with heavy steel plates The whole thing is mounted on a strong girder base in order that the room can be easily erected on brick work or concrete foundation. The floor is composed of perforated steel plate, and underneath is a welded steel hopper (or hoppers), the upper flanges being bolted to the angles at the base and the lower delivers into the boot of the bucket elevator. As the abrasive falls through the perforated plate to the hopper and is conducted to the bucket elevator, it is raised and discharged into a rotary sieve in the top of the separator by means of a rubber and canvas belt on which are fitted suitable steel buckets. Provision of either screw conveyors or belt conveyors from the hoppers to the boot of the bucket elevator allows for shallower pits and eliminates the necessity for a relatively deep it otherwise required for the hopper to deliver directly into the bucket elevator, because of the angle of repose of shot in the corners of the hoppers being about 40°. During the operation the room, bucket elevator casing and settling chamber are all under the action of the exhaust system in order to take out dust.

The automatic rotary screen and dust separator has a pneumatic device fitted at its top chamber for removing the dust from the abrasive. While light dust is drawn out by the exhaust system working in conjunction with a dust arrester, heavy dust comprising bits, nails etc. are taken out through a separate pipe allowing reclaimed shot thereby to fall into the pressure chamber.

The dust arrester which is used in conjunction with the shot blasting plant comprises a steel plate chamber into which the dust-laden air is drawn by exhaust fan. Inside the chamber are fabric dust tubes of an area such as will effectively remove dust from air drawn in. The dust tubes are individually suspended on hooks at the top and have sealing rings at the bottom which can be readily fitted into apertures in the bottom plate of the dust arrester. A hand operated vibrator device is fitted for giving vibration to the dust tubes (to be operated when the exhaust fan is shut down) to remove adherent dust.

For the easy conveyance and manipulation of the work, shot blast room plants are sometimes equipped with turn tables, runways, bogie rails, roller conveyors and when preferred with a revolving table installed half in and half out of the room for convenience in loading and carrying out an almost continuous operation.

Shot blast room are generally designed to handle cast iron and steel castings, ranging from 1/2 cwt. to several tons in weight and their areas also accordingly vary from about 6 feet square up to, say 50 feet long depending on individual requirements and space available.

Just as the room plant is installed where a wide variety of relatively heavy parts are to be treated and the output is sufficiently large, so is the cabinet type of machine employed where general light work is contemplated. In the cabinet type, the greatest advantage lies in the fact that the operator works from outside with the aid of window for sighting and gets a greater personal comfort in as much as he is free from dusty atmospheric conditions. In this machine, two arm holes are provided, one for directing the jet and the other for manipulating the work so that adequate treatment at special point is ensured in the same way as though the operator were in a room.

TUMBLING BARRELS

The shot blast plant of the tumbling barrel principle is the mot effective economical method of cleaning small castings and forgings in bulk. Compared with shot blasting processes described earlier, this is a very slow process, but this slowness is advantageous, as it results in the work surfaces being given a polished, burnished finish arising from constant rubbing together of the castings or forgings dealt with.

A complete installation of this type of plant comprises, the tumbling barrel, a shot blast apparatus, dust arrester and exhaust system and the compressed air supply.

The operation may be described as under :—

In the tumbling barrel which consists of a strong perforated steel cylinder, the work pieces are placed and the cover fastened. The barrel is fitted with cast iron end plates which form a roller track, supported on its periphery by four rubber-covered rollers, on which the barrel slowly revolves at a rate of about 3 revolutions per minute. The barrel is fitted inside a strongly-constructed cabinet with counter-balanced lifting door with balance weight, rope and pulley. This lifting door is kept closed when the plant is in operation, forming a dust-tight chamber. The blast is directed from one or both ends of the barrel striking the articles placed therein at a position where the bulk is concentrated. As the barrel slowly rotates, the articles inside, tumble over each other, bringing new faces under the action of the blast. The abrasive and dust pass through the perforations in the barrel into the cabinet from which dust is drawn off by the exhaust system to the dust arrester and the spent abrasive falls by gravity into the mixing chamber or, in the case of the larger installations raised by a bucket elevator and dropped by gravity into the separator. Whatever type of barrel is used, to prevent dust escaping to the atmosphere it is necessary to maintain a partial vacuum in order that the leakage of air shall be inwards. Sometimes a chute for the cleaned articles is fitted under the barrel to facilitate the loading of trucks from the apparatus.

AIRLESS WHEELABRATOR

Mechanical impact blasting by means of wheelabrator probably represents the most important development in shot blasting machinery. This amazing device patented by the American Foundry Equipment Co., Mishawaka, Indiana, has unquestionably set the highest standard of efficiency ever attained in an abrasive cleaning machine.

The greatest advantage in this process is that no compressed air is required, as a result of which such equipments as air compressor plant mixing chamber, piping, hose, nozzles, control valves etc. can altogether be eliminated.

The wheelabrator is composed of two main parts viz : the abrasive throwing wheel which throws out the abrasive centrifugally and that part which passes the the work to be cleaned under the action of the abrasive.

The abrasive throwing wheels are generally of two types, viz., the batter type and the slider type. In the batter type there is one single main plate on which blades, made from abrasive resisting alloy iron, are mounted. Abrasive is gravity fed on the impeller blades of the wheel at an angle and is ultimately discharged at the periphery by the blades. The setting of the shot nozzle in relation to the blades determines the direction of the throw of the abrasive.

In the slider type abrasive propelling wheel, made of two steel plates bolted together with distance pieces, shot is guided from a central control cage outwards on to eight radial blades of special hard alloy iron. By rotating the control cage, the abrasive may be made to leave the wheel in any pre-determined direction. Abrasive is fed from the storage hopper by means of the feed funnel and feed spout to a small impeller wheel secured to the main wheel and revolving at the same speed while the control cage is held stationary. Through the slot of the control cage the abrasive passes on to the inner edge of the blades at a very low velocity and from this point the shot slides by centrifugal force to its discharge from the outer edge of the blades which corresponds with the periphery of the wheel.

The wheel which is overhung on the end of a shaft held by two bearings is driven by a V-rope at a speed of 2,250 r. p. m. which has been very carefully determined as the wheel become ineffective when the speed falls below this figure. It has been observed that at a speed of 1,800 r.p.m. the effective work obtained is only about one half of what it would be at the correct speed.

After cleaning the components, the spent abrasive falls by gravity into the boot of a bucket elevator which raises it to the top of the cabinet and discharges it through a sieve which separates all foreign matter. At the same time the flow of shot is "washed" by streams of air drawn through the sieve by means of the dust extractor. The clean abrasive then fall into the storage chamber and is then fed by gravity into the centre of the wheel for re-use.

The second part of the wheelabrator plant differs in each type. The work is brought under the action of the abrasive by such equipments as endless chain conveyor, which, connecting with two circular plates, forms a barrel, rotary tables of the plain table or multi-table design, flat belt conveyors, roller conveyors, overhead conveyors and so on.

TUM BLAST MACHINE

The barrel type or what is commonly known as the tum blast machine is the first one to which the mechanical impact blasting principle was applied. This has still the widest application and is of the most popular type being very suitable for dealing with large quantities of small components. As in the case of direct pressure tumbling barrel, the materials handled are cascaded one over the other and completely brought to the full abrasive blast action. The operation, being carried out in an enclosed chamber, is considered as the most hygienic method. For quicker production, the machine is equipped with bucket leader, operated electrically for loading the charge while it unloads itself by reversing the endless chain conveyor whose movement is also controlled electrically.

The wheelabrator rotary table or multi-table machine and the flat belt conveyor type are primarily intended to deal with work of a flat nature. In these machines if both the surfaces are required to be cleaned, the work will have to be turned over and passed in again so as to present the fresh surface to the impact of the abrasive stream.

For cleaning large forgings or castings of uniform shape, an overhead conveyor is used to pass them through the cleaning chamber. The components are suspended from the overhead conveyor (the roof of the room and vestibules having rubbered slots for the passage of slings). The conveyor trolleys are fitted with rotary hangers, which by means of a secondary drive are caused to rotate for rotating the components as they pass in the line of abrasive. The arrangement is such that each hanger gives one complete revolution for exposing the complete surface to the action of the abrasive stream, so that cleaning may be completed in one pass.

SHOT PEENING

Shot peening, which is a cold work-hardening process and designed to increase the tensile strength of springs in addition to removing any slight surface scale formed during the heat-treatment process, represents another development of shot blasting.

In this process, steel or iron shot is impelled against the surface of the spring at a relatively high velocity, either by an air-blast, or centrifugal force. The latter system known as "Wheel-a-peening" is more popular specially where a reasonably accurate control of the peening intensity is required. It is because while the speed of the impeller wheel can be determined precisely, the air-blast pressure is always liable to fluctuate. Further in the air-blast system the nozzle through which the shot is forced out, is liable to erode rapidly, as a result of which the rate of feed of shot on to the workpiece varies greatly.

In shot peening each grain or shot acts as a peen hammer and the impact causes cold flow of surface, resulting in a re-distribution of surface fibres and consequent increased resistance to fatigue of the part treated. Depending on the nature of the metal and the intensity of the impact, which is its turn is dependent on the size of the shot, the velocity with which it strikes the surface, the weight of shot reaching the surface in unit time, and the angle at which the surface is presented to the stream, a cold work-hardening effect in the top layer, extending to a depth of 0.005 in. to 0.01 in. below the surface, may be obtained. Remarkable results in increased fatigue life have been obtained from the shot peening of springs, both leaf and coil and its application has also been extended to such items as torsion bars and other parts which are under bending or twisting stresses. It may be mentioned in this connection that it is always the tension side which is exposed to shot peening action so that the inner fibres in their effort to force the outer fibres to return to a shorter length than that at which the stretched fibres would tend to remain, produce a resultant compression in the outer surfaces and a tensile stress in them.

The equipment consists of a projecting device either in the form of the air nozzle or abrasive propelling wheel as already stated earlier, shot separator, shot stabiliser, shot adding mechanism, the work carrier and cabinet, and an exhaust system. The working principle is more or less on the same lines as those of the other shot blasting equipments described earlier.

HYDRO BLAST PROCESS

During recent years there has been considerable development of the wet cleaning process, which offers several important advantages over shot blasting, including the elimination of dust. By this process a stream or water or a chemical emulsion and sand is directed under pressure of approximately 1200 lb. per square inch on to the face of the material to be cleaned, through a nozzle connected to a flexible hose. The nozzle is usually of the injector type into which a mixture of abrasive and water is gravity fed and they are forced out by either compressed air or steam with a velocity in the region of 16,000 ft. per minute.

The flexibility of application of the hydro-blast is of immense help in removing hard and complicated cores of castings in addition to cleaning sand from the casting surfaces. The system is so designed that the core and moulding sand may be reclaimed either for moulding purpose or for re-use in the system.

The plant is more expensive than ordinary shot-blasting equipment and the quantity of work to be handled largely dictates the necessity for installing it. It is considered that where the quantity to be handled in a day exceeds 10 tons and the components are sufficiently intricate to make difficult the employment of shot-blasting, its installation is economically justified.

A more useful application of the plant lies in removing machining marks previous to polishing. For such purposes, the nozzle is presented to the surface at an angle and the abrasive solution or mixture propelled over the surface of the object evenly.

For easy conveyance and manipulation of parts to be dealt with, such equipments as automatic conveyors, turntables, belt conveyors etc., are arranged depending on individual requirements.

VACU-BLAST PROCESS

Vacu-blast is perhaps the most recent development in the abrasive process and being a dustless blast cleaning method, having been originally developed in the U.S.A., is finding an increased favour in other countries as well. Furthermore its adaptibility of being used as a portable unit has made it more popular in railway workshops where this is being used mainly for cleaning the panel plates of both wagons and carriages prior to painting.

The complete installation comprises, essentially three main units, viz: the blast gun, the abrasive control unit, and the dust collector. The blast gun may be used as a portable equipment or can be built into various types of processing unit. The portability of the equipment can be further explained by the fact that the blast gun can be operated effectively at a distance of 100 Ft. from the abrasive control unit which in its turn may remain at a distance upto 300 Ft. from the dust collector. A completely self-contained and portable installation may be arranged by mounting the units on a chasis, together with a suitable engine driven compressor.

The blast gun made up of a cast aluminium alloy casing and weighing only 9 lbs. has a central blast nozzle of tungsten carbide with a bore diameter upto 5/16", fitted to it. A specially developed bristle and fibre brush, fitted at the lower edge of the casing is so arranged that while resting on the surface of the work to be cleaned, it forms a seal to prevent the escape of spent abrasive allowing at the same time sufficient air to be drawn in for removing the abrasive and other impurities through the annular space between the casing and the housing carrying the blast nozzle.

The spent abrasive and dust is first drawn into the upper part of the abrasive control unit which is connected to the air compressor. The action of the unit is

automatically controlled by means of an electro-pneumatic system. The function of the unit is to separate out usuable abrasive from the expended one and pass on other particles to the dust collector which incorporates a Root's type blower running at 1,100 r.p.m. and drawing 300 Cu. ft. of air per minute.

The usual abrasive is first collected in a storage hopper from which it passes to an intermediate pressure storage tank and thence to a pressure feed tank connected to the compressed air supply line and fitted with a specially designed feed valve for feeding abrasive to the blast hose. Similar valves are also fitted between the storage hopper and the intermediate pressure storage tank, and between the latter and the pressure feed tank. The action of these valves is so controlled by the electro-pneumatic system, that the abrasive is allowed to pass periodically from the hopper, which is always under vaccuum, to the pressure feed tank which is always under pressure from the compressed air, so as to ensure continuous operation of the gun.

The abrasive is fed to the gun through a soft rubber-lined hose which is connected to the pressure tank and incorporates two electrical leads terminating in a remote control switch adjacent to the gun. The switch operates the specially designed air valves mentioned in the foregoing para and so long this switch is on there is continuity of supply of abrasive to the gun.

The power consumption for the electro-pneumatic system is 70 watts at 220 volts. The control unit is 6 ft. 8 in. high and weighs 8 cwts. while the dust collector is 6 ft. 3 in. high and weighs 12 cwts.

The blower in the dust collector draws as much as 300 Cu. ft. of air per minute through the gun, abrasive control unit and dust collector, as a result of which provision for any auxiliary supply of air for the operator, to ensure healthy working conditions, while working in enclosed spaces, is rendered unnecessary.

Although there has already been considerable improvement in the design features of the modern sand/shot blasting equipment commensurate with the new demands of Industry, continued research is still being carried on to achieve the ultimate in shot blasting practice and also to open up new avenues for new application of this process in other fields for reasons of economy and speed.

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TANJORE (S. I.)

Perambur Coach Factory takes shape towards Self-sufficiency in Railway Coaches

*By Sri K. Sadagopan **

SINCE the attainment of independence, the Railway Ministry have been following a vigorous policy of attaining self-sufficiency at the earliest possible date in the matter of railway equipment, with a view to cutting out dependence on foreign countries.

So far as locomotives are concerned, the establishment of the Chittaranjan Locomotive Works and the Tata Locomotive Engineering Co. will enable us almost fully to meet requirements of locomotives not only for replacing old and worn-out locomotives, but also for providing the Indian Railways with additional locomotives, so that, with the increasing economic development of the country, in all spheres of production and distribution, the railway transport system may fulfil its role and efficiently discharge its responsibilities.

So far as goods wagons are concerned, Government's policy has been that the development of the requisite production capacity should be planned in the private sector. The present capacity in the private sector for the manufacture of wagons is about 12,000 to 15,000 wagons a year. Government are constantly exploring sources in the private sector to build up a higher wagon building capacity.

As regards the various other items of railway equipment which at present are being imported, Government have constituted a high-power committee to suggest the steps to be taken to achieve self-sufficiency to the maximum extent possible.

So far as passenger coaches are concerned, the position at the time of independence was that, while on the one hand we were left with a badly depleted and deteriorated coaching stock as compared with the position in 1939, on the other we had taken on the responsibility for moving passenger traffic which, during the war and post-war periods, had registered an enormous increase of over the 1939 level of traffic, with the inevitable consequences of poor performance and over-crowding on an unprecedented scale.

With a view to meeting this serious situation and affording the maximum relief possible, Government had to follow a policy of large-scale import of passenger coaches from abroad. It also became absolutely manifest that, taking into account all available sources of indigenous capacity for the manufacture of coaches, a large separate manufacturing unit similar to Chittaranjan Locomotive Works, for meeting out requirements of coaches, was inescapable. Accordingly, in 1948, a decision was taken by the late Shri N. Gopalaswamy Ayengar, the then Minister for Transport and Railways, that a separate factory for the production of broad gauge coaches should be established in the country.

B. G. STANDARD COACH OF FUTURE

The next question was the type of passenger coach that should be adopted as the standard. Several types of coaches were examined by the railway technical chiefs and the decision was taken that the light-weight, all metal integral and tubular design would be the best, and should be adopted as the standard. This design, which was offered by a Swiss Coach-building firm, Messrs. Swiss Car & Elevator Manufacturing Corporation, Ltd., Schlieren, Zurich, Switzerland, was accordingly accepted by Government.

ADVANTAGES OF INTEGRAL COACH

The advantages of the type of coach to be built in the factory at Perambur, are:

(i) The design incorporates the principles of integral tubular construction which enables the forces sustained by the coach to be borne by the entire body including the skin. This design, therefore, results in the maximum economy of material for a desired strength and is therefore about seven tons lighter than the conventional design, weighing only 35 tons as against 42 tons of the present all-steel coach of the conventional type.

(ii) The design incorporates anti-telescopic end construction. This design, combined with the fact that the carriage will be of all-steel welded construction, would reduce the possibility of the carriages telescoping in the event of an accident.

(iii) The carriage is designed for improved riding by the provision of shock absorbers and coiled spring axle box suspension. The bogie trucks are of the latest

* *Chief Administrative Officer, Integral Coach Factory, Perambur.*

all-welded Swiss design. The axle boxes are fitted with S. K. F. roller bearings, making for smoother movement.

(iv) The coach will be sprayed with Limpet asbestos as an insulation against heat and noice.

LOCATION OF FACTORY

As regards the location of this large manufacturing unit, several alternative sites including Bangalore were considered, and it was eventually decided that this factory should be located at Perambur, Madras. Perambur is already a big railway workshop centre, and sufficient railway land was readily available for going ahead with the construction of the factory. Railway facilities for the transport of material, etc. were available on the spot. With the location of the factory in Madras, there was also no compelling need for establishing immediately a large colony for housing every worker, and consequently it was felt that the finances made available to the Railway Ministry could be put to the maximum productive use by way of the establishment of the factory proper.

The factory consists of ten shops with a total covered area of 8,48,600 sq. ft. and has been laid out on the most modern lines. The planning of the factory has been such that the raw materials is received at one end of the shops and processed through the factory in a uniflow direction and the finished coach shell rolls out at the other end.

PLANT AND MACHINERY

The question of equipping the factory with the most modern plant and machinery was taken up in time so that there might be no time-lag between the completion of the civil engineering works and the installation of plant and machinery.

As far as possible, machines of indigenous manufacture were ordered. But the machine tool manufacturing capacity in the country not yet having fully developed, it became inevitable to import the vast bulk of our machinery requirements from abroad. Accordingly, global tenders were called for in November 1953, and the tenders were received and finalised by March–April 1954.

It is indeed a matter for special gratification that it has been possible to obtain very competitive and favourable prices and very early deliveries. The following figures give the rough break-up of the orders in West Germany, U. K., Switzerland and other countries:

Country	*No. of contracts*	*No. of machines*
Germany	78	152
Switzerland	31	312 (includes 260 welding sets)
England	23	68 (includes 25 welding outfits)
Sweden	3	3
Czechoslavakia	3	6
France	1	1
Belgium	1	1
Italy	1	1
Total	141	544

RAW MATERIAL PROCUREMENT

Simultaneously with the procurement of plant and machinery, action was initiated for the procurement of numerous items of raw material required for the production of the coach, both from abroad and from indigenous sources. The bulk of our steel requirements has had to be imported in the first instance, but care has been taken to ensure that with the new steel plants coming into production, our entire requirements of steel are obtained from these steel rolling mills.

TECHNICAL TRAINING

The most urgent problem calling for attention in the context of the second Five Year Plan, is one of making nation wide arrangements for the training of technical personnel at all levels, so that we may have technical man power on a scale sufficient to meet the demands for the implementation of the Plan. The need for properly trained skilled workers in the various technical categories was foreseen at the very early stages of this project.

In March 1954, a Technical Training School was started, and the inauguration of this School was performed by Shri O. V. Alagesan, Deputy Minister for Transport and Railways. Boys who have already received basic industrial training have been recruited and given an extensive course in the particular trade for which they are most suitable, both in the school and on the shop floor. Thus, the timely starting of the technical training school has enabled us to find the nucleus of skilled craftsmen to help in the starting of production in the factory, as originally planned. No pains have been spared to make the training school a model institution and to give the boys the best possible technical education.

The training methods have been planned with the utmost care, and due emphasis has been given to the correct practical training of the boys. For each department of training, viz. welding, fitting and machining, a

(Continued on page 12)

from strength to strength in steel

FRAMED IN STRENGTH OF STEEL BUILT FOR ENDURING SERVICE

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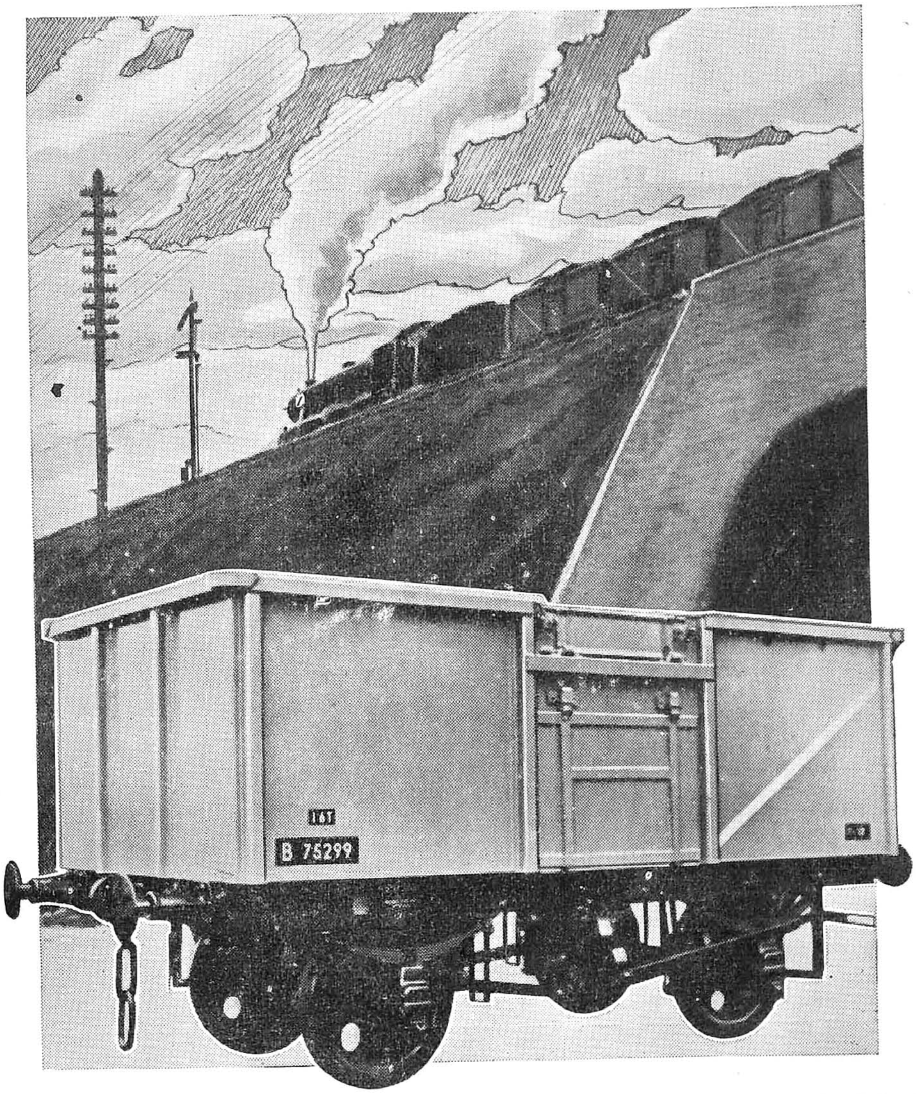
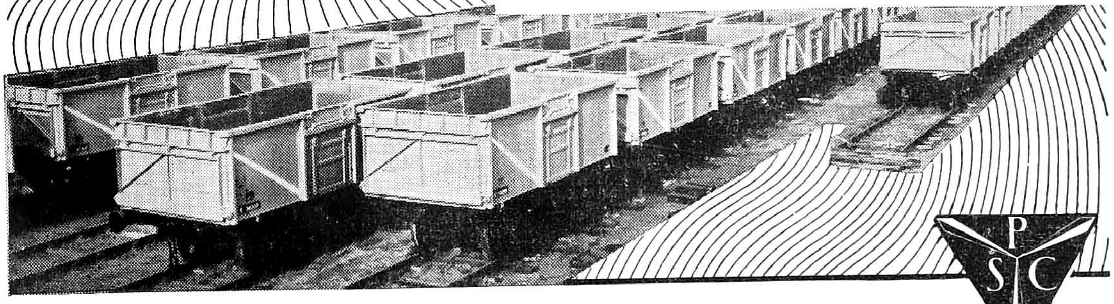


FRAMED IN STRENGTH OF STEEL BUILT FOR ENDURING SERVICE



RAILWAY DIVISION, PAISLEY, SCOTLAND

HEAD OFFICE COWLEY, OXFORD

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Shenfield-Chelmsford-Southend Electrification

IN connection with the overhead electrification by the British Transport Commission of the line linking Shenfield and Chelmsford with Southend (Victoria), in Essex, the contractors, British Insulated Callender's Construction Company Limited, in co-operation with Messrs. Wharton Engineers (Elstree) Limited, have developed a new design of mechanical equipment to speed up the progress of the work. This is a construction train consisting of an earth-boring unit, a steel-work erection unit and a concreting unit.

The holes for the foundations of overhead structures for electrification in this country have previously been excavated by hand, concrete materials being dumped and mixed on site. The erection of the masts and grouting in have been separate operations which necessitated later visits to the site.

The equipment which is now being used makes it possible for all operations to be performed in sequence during one visit. A hole is bored in the ground by a mechanical auger, a temporary ground frame is placed over the hole and the mast is erected in the ground frame. Concrete, mixed on the train, is then poured into the foundation hole and the sequence of operations is complete. In this way a construction unit will enter a section of line on which no work has hitherto been done and in four or five hours will leave, having completed all the foundations and erected all the masts on one side of one mile of track.

The construction unit consists of the three separate parts—the first part contains the earth-boring unit which proceeds to bore the holes as required, temporary ground frames being placed over the excavated holes. This is followed by the steel-work erection unit drawn by a self-propelled steam crane which lifts the masts into the excavations where they are held in the steel ground frames at their correct position and height. The third part is the concreting unit which fills the excavations.

The earth-boring unit consists of a boring head driven by a diesel engine, all mounted on a railway wagon. The unit can be made to travel along its own truck, to rotate about its axis, to traverse in an across-track direction, to be raised or lowered and to be adjusted to the vertical for any cant of track. In this way the unit can be quickly and accurately positioned. Holes measuring from 2 ft. to 3 ft. 6 ins. in diameter can be bored and the maximum depth of bore is 12 ft. The holes can be bored up to a distance of 13 ft. 6 ins. from the centre line of the track. As far as is known, no other augering unit has embodied all these features.

The concreting unit, also mounted on a railway wagon, is made up of two electrically-driven mixers, each embodying a weigh batcher. Between the mixers is a specially designed placer unit which is electro-hydraulically operated. A telescopic jib enables the concrete, which is taken from each mixer in turn, to be placed in the hole. Power for driving the concreting unit is obtained from a diesel-electric set mounted on another wagon. This same wagon carries pumps for delivering water to the mixers and a rotary compressor for operating concrete vibrators and other tools.

The date for the introduction of electric services to Southend (Victoria) was originally set at 1st January 1957. Very good progress is being made with electrification of this section and it is confidently expected that this date will be met.

Until electrification has been carried beyond Chelmsford only the local services between Shenfield and Chelmsford will be operated electrically. These will be covered by extending existing electrified services working between Liverpool Street and Shenfield. Such good progress has been made on the Chelmsford section of the electrification that it is proposed to inaugurate electric working with the introduction of the Summer Timetable next year.

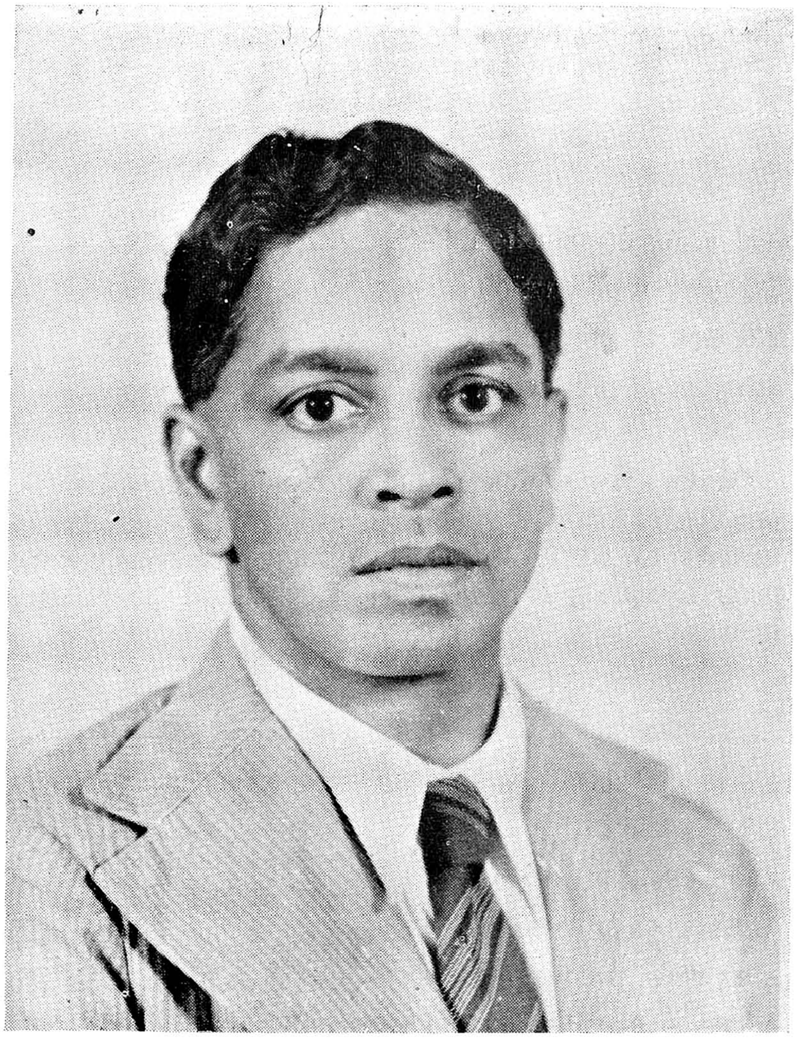
HYDERABAD-MADRAS THROUGH CARRIAGE

A through 3rd class bogie with facility for seat reservation, has been introduced both ways between Hyderabad and Madras running three times a week on the dates on which 17 Down and 18 Up tri-weekly Madras-Delhi Janata Express trains run.

The through bogie leaves Hyderabad on Saturdays, Mondays and Wednesdays by 319 Down Hyderabad-Kazipet Express train and is attached at Kazipet to the connecting 18 Up Delhi-Madras tri-weekly Janata Express arriving Madras on the following day. In the opposite direction, the bogie leaves Madras on Saturdays, Mondays and Thursdays by 17 Down Madras-Delhi tri-weekly Janata Express and arrives at Hyderabad by 320 Up Express train on the following morning.

SHRI M. GANAPATI, NEW GENERAL MANAGER, WESTERN RAILWAY

Shri M. Ganapati, B. E., M. E. (Hons.), M. I. E. (Ind.) Development Commissioner, Kandla Port Project, who has been appointed as General Manager, Western Railway, was born in November, 1903. He joined the former East Indian Railway in 1928. In October, 1945, he was placed on special duty as Deputy Chief Engineer in charge of the regirdering of the Malaviya Bridge at Banaras. In January, 1948, he was appointed as Engineer-in-Chief of the Chittaranjan Locomotive Works. On completion of this Rs. 15-crores project in March, 1951, he was appointed as Engineer-in-Chief of the construction of the Integral Coach Factory.

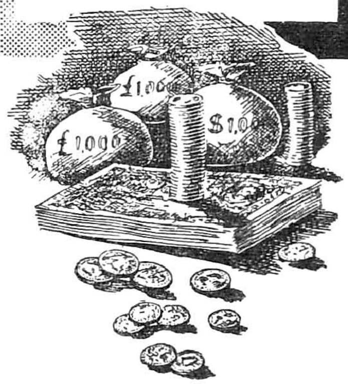


Shri M. Ganapati

In April, 1953, his services were requisitioned by the Ministry of Transport and he was appointed as Development Commissioner, Kandla Port Project—another big project costing about Rs. 15 crores. Two stages of work in the Bunder and the Oil Jetty, which form part of the major harbour works construction at Kandla, having been completed and the main stage of work in the construction of the Cargo Jetty being in full swing, Shri Ganapati has been recalled for service on the Railways and has been posted as General Manager, Western Railway.

In recognition of Shri Ganapati's outstanding services as an Engineer, the President of India conferred on him the award of " PADMA BHUSHAN " on 15th August, 1954.

India's Tea- India's Wealth



FOREIGN EXCHANGE

Indian Tea earned over Rs. 147 crores in terms of foreign exchange during 1954-55.

TEA BOARD INDIA

No other drink refreshes you so much, yet costs so little as TEA

IST 148

(Continued from page 8)

special Swiss instructor is attached to give his wholetime attention to the training of the apprentices in his charge. It is a matter for gratification that our Swiss collaborators are very satisfied with the willingness and the capacity of the boys to pick up technical knowledge and skill, and there is every reason to hope that in so far as technical skill is concerned, the boys turned out of this school will compare favourably with craftsmen in the industrially advanced countries.

In establishing production of this new type of railway passenger coach, the importance of having a sufficient number of experienced men trained abroad in the detailed processes of production need hardly be stressed. Accordingly, action was taken at an early enough stage of the project for the selection of suitable men in the rank of supervisors and also in the rank of skilled workers from the workshops of the Indian Railways, and for their deputation to Switzerland for practical training, for periods varying from six to twelve months in the works of our collaborators, Messrs. Swiss Car & Elevator Manufacturing Corporation Ltd. Schlieren, Zurich. So far, 40 such men have received their training and returned to India, and have assumed their respective positions in the production organisation. Another 19 men are at the moment undergoing training in Switzerland.

TECHNICAL COLLABORATION

The integral coach being a new design of coach in the manufacture of which our Indian mechanical engineers have no previous experience, it was essential that for the successful establishment of the production we should acquire the ' know-how ' from engineering firms who have considerable experience and have built up a reputation for the production of this type of coach. Accordingly, a technical aid agreement was entered into with a Swiss engineering firm—Messrs. Swiss Car & Elevator Manufacturing Corporation Ltd. Schlieren, Zurich.

The main provisions of this agreement are : (i) The firm accept their full share of technical and executive responsibility for establishing the manufacture of the integral type of coach in the factory; (ii) The firm agree to supply workshop drawings and specifications for machinery and plant in connection with the construction and equipping of this factory for the manufacture of coaches upto the agreed production targets ; (iii) The firm agree to supply technical assistance to Government by receiving in their factory in Switzerland such technicians and engineers as may be mutually agreed between the firm and the Government for the purpose of training them in the offices, laboratories, workshops, inspection and other departments of the firms ; and (iv) The firm agree to supply whole-time technical personnel for employment in the factory for such period or periods as may be agreed between Government and the firm.

The payment of basic fees by Government to the firm for their technical collaboration has been made contingent on the firm establishing production targets, from year to year, as embodied in the Agreement.

PRODUCTION TARGETS

The following production targets have been agreed between Government and the firm :

Target	*No. of unfinished coaches*
1st year of production	20
2nd year of production	100
3rd year of production	200
4th year of production	300
5th year of production	350

Of the above numbers, the Agreement contemplates a progressive increase, vide details below, in the number of coaches to be turned out by using indigenously made parts excepting for wheels and axles and proprietary items.

Target	*No. of indigenously manufactured coaches*
2nd year of production	20
3rd year of production	120
4th year of production	280
5th year of production and thereafter	350

The writer has had the rare opportunity of having been associated in the conclusion of the present technical aid agreement with Messrs. Swiss Car & Elevator Manufacturing Corporation Ltd. and on the conclusion of this agreement of being entrusted with the responsibility of working the technical collaboration smoothly and successfully.

(Continued on page 13)

Development of the individual axle drive for bogie-type Diesel hydraulic locomotives

By Dipl. Ing. Heinrich Herrmann, Essen

IN 1942, Fried. Krupp Lokomotivfabrik supplied one Diesel hydraulic locomotive with a total horse power of 2,000 H.P. to the Norwegian State Railways. It was the result of a 20 years study of the mechanical and electric transmission systems, and on the basis of this study it was decided to design Diesel hydraulic locomotives.

In a similar manner to steam locomotives, all these locomotives were built with a rigid frame, the axles being driven by connecting and coupling rods and one or two jackshafts. Thus the a/m locomotive for Norway was built with axle arrangement 1–B–B–1 (2–4–4–2), each pair of driving axles being driven by one of the two Diesel engines, through its own KRUPP hydraulic transmission of the Lysholm-Smith type, and jack shaft. The locomotive was equipped with carrying axles, provided to facilitate the negotiation of curves. The distribution of the driving power on two engines each driving two axles represented an individual drive for each axle.

In keeping with the bogies with individual axle drive for electric locomotives, this design was also adopted for Diesel electric locomotives, particularly in the United States of America. As a result of the studies made by Fried. Krupp Lokomotivfabrik during the past years, Diesel hydraulic bogie-type locomotives were built with a genuine individual axle drive. The locomotives is driven by the Diesel engine, mounted on the main frame, via the hydraulic transmission, and cardan shafts which transmit the power to the bogie axles which are not connected together mechanically.

Compared to the electric power transmission where the nose-suspended traction motors cause a high axle load, the axle load is considerably lower with our axle drive and consequently a lower weight of unsprung

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(Continued from page 12)

SALIENT DATA

Given below are the salient facts pertaining to this project:

(i)	Covered area in the shops	8,48,600 S.ft.
(ii)	No. of sheds	10
(iii)	Tonnage of steel for the project	9,500 tons
(iv)	Length of railway lines	12 miles
(v)	Roads inside shops	3·4 miles
(vi)	Roads in colony	3 miles
(vii)	Houses	400 units
(viii)	Water supply pipes	16 miles
(ix)	Consumption of cement	19,500 tons
(x)	No. of machines in the Factory including welding sets:	
	(a) General purposes	549
	(b) Special purposes	60
(xi)	Jigs and fixtures	750
(xii)	Pipelines (Cooling water; Oil; compressed air)	8·4 miles
(xiii)	Compressors	8250 Cft/Min.
(xiv)	No. of cranes/traversers:	
	(a) 20-ton overhead cranes	4
	(b) 5-ton overhead cranes	26
	(c) 75-ton traversers	2
(xv)	No. of workmen to be employed	4,000
(xvi)	Annual output in single shift	350 (unfurnished coaches)
(xvii)	Total consumption of electrical units per annum	6 million units
(xviii)	Total cost of the project	Rs.7·35 crores

TEAM SPIRIT

The successful and timely execution of major project of national significance is possible only when there is the most cordial team spirit, and a missionary zeal to accomplish the allotted task on the part of all concerned, viz. the officers and staff of the project at all levels, the steel producers, the raw material suppliers, the fabricating and building contractors, and the plant and machinery suppliers. If, on this project, it has been possible to inaugurate production according to Schedule, this is due entirely to the effective contribution made by all the parties concerned in building up this project and their cheerful and enthusiastic co-operation.

masses was obtained. This resulted in substantially reduced stresses on the structure, improving the running properties of the locomotive.

The following is a description of a 1200 HP Bo'Bo'Bo' type Locomotive designed in accordance with this procedure and supplied early in 1953 to the Algerian Railways.

The chief characteristics of this locomotive are as follows:

gauge	4″-8½ to 3′-3 3/8″
diameter of driving wheels	3′-3 3/8″
bogie wheelbase	7′-10″
distance from pivot to pivot	2×19′-8″
total wheelbase	47′-3″
total length (buffers included)	60′-3″
maximum width	9′-1″
maximum height	13′-3″
continuous engine rating	2×550 = 1100 HP
one hour engine rating	2×610 = 1220 HP
maximum starting tractive effort abt.	48500 lbs.
service weight	163142 lbs.
axle load	27550 lbs.
maximum speed	50 mph

The locomotive is of the articulated type carried on three 2-axle bogies. The frames of the two sections are supported on the centre bogie. Each of the two sections of the locomotive carries under a hood the Diesel engine, main transmission gear, cooling system and all auxiliary equipment required for the Diesel engine and for the operation of the locomotive. All this equipment is rigidly mounted on the locomotive frame. The driver's cab is arranged on one of the two sections of the loco above the centre bogie The bonnets of the two power compartments being lower than the driver's cab, a good view is offered in both running directions. From the main transmission gears, all bogie axles are driven by means of cardan shafts.

The two engines are four-stroke MAN Diesel engines of type W6V 22/30 supercharged by means of an exhaust-gas turbo blower. The Diesel engines develop a continuous rating of 550 HP each at 900 RPM and a one-hour rating of 610 HP each at 1000 RPM. They are water-cooled and are started by means of compressed air. The power of each Diesel engine is transmitted from the crank shaft via an elastic coupling on to a step-up gear, which drives three hydraulic torque converters running at higher speed. The hydraulic transmissions are KRUPP hydraulic torque converters, fitted with 1/pump blades. These blades can be moved in such a way that they form a closed ring. In this case, the circulation of the converter liquid, being a thin fluid oil, is stopped and no transmission of power takes place. If the engine speed is reduced to about 500 RPM., the transmission runs idle and it is not necessary to empty the hydraulic torque converters. Consequently the transmissions are at once ready for starting again and they work instantaneously when the blades are opened from the cab by means of the control instruments. It is left to the discretion of the driver, to start rapidly or slowly, with a high or low tractive effort, as may be required by the operating service. During service, the blade position of the pump wheels is automatically changed and adapted to the various circulating conditions, existing at different running speeds due to the various speeds of the turbine wheel. As a consequence, a wide speed range with a good efficiency is obtained so that for the maximum running speed of 50 mph the use of only two speed stages will be required.

Each hydraulic transmission has its own spur wheel speed change and reverse gear which are all accommodated in the same welded housing which is rigidly mounted on the main-frame between the bogies.

The change speed and reverse gear from the reduction gear which has three secondary shafts carried in supporting bearings fixed on the main-frame, two of which lead to the adjacent outer bogie and one to the centre bogie. The elevated shafts leading to the outer bogie are in connection with an intermediate gear also fixed on the main-frame and from which the inner axle of the bogie is driven by means of a cardan shaft and an axle gear. The outer axle is driven from the inferior shaft of the supporting bearing also by means of a cardan shaft and an axle gear. The outer axle is driven from the inferior shaft of the supporting bearing also by means of a cardan shaft and axle gear. The third shaft leading to the centre bogie passes above the axle of this bogie adjacent to the main transmission gear and drives the far axle. The result is that the cardan shafts, which have to take up the vertical movement of the axle as well as the rotatory movement of the bogies, are arranged symmetrically to the pivot, thus

maintaining uniformity of rotation. All drives are obsolutely independent of each other, so that differences in rotation of each shaft due to wear on driving wheels caused by negotiating curves etc., will be compensated by the individual hydraulic torque converters. This compensation is wide enough to permit the use of axles having tyres with substantially varying diameters.

This transmission of power, therefore, represents a genuine individual drive of each axle as is the case with electric transmission.

The change from one speed stage to another automatically occurs according to the running speed. The reverse gear is shifted by means of dog clutches, but this can only be done however during standstill of the locomotive. All change gear parts are contained in the main transmission gear thus dispensing with control rods to the bogies.

The power regulation of the locomotive from the cap as well as the regulation of the blades of the transmission is effected by a single lever. The pump blades inside the transmission are automatically regulated in the following manner:

According to the hydraulic law of the converter, the primary torque of which increases with the square of the pump wheel speed, a pre-determined amount of fuel is fed to the engine cylinders for any engine speed selected by the driver. Therefore the engine can transmit torques, which are in relation to the primary torque of the transmission at a corresponding engine speed. Should the actual amount of fuel adjusted by the engine regulator deviate from this pre-selected value, a control device is operated which automatically alters the pump blade position so that the actual amount of fuel delivered to the engine will be in accordance with the pre-selected value. The engine and hydraulic torque converter are then working with their optimum combined efficiency. At the same time, this automatic control device protects the engine from overload, as the amount of fuel can never exceed the pre-determined amount.

On the control desk are situated the power regulation lever, and next to it, the forward-and-reverse lever. These are interlocked so that the direction control lever can only be moved when the power lever is at idle running position. Conversely the power lever can only be moved when the direction control lever is in its forward or reverse position. In addition to these 2 levers there are controls for air pressure and vacuum brakes and the usual engine control dials. There are 2 control tables in the cab arranged diagonally opposite each other, for each travelling direction. The two engines have common pneumatic controls but can be driven individually or together as desired. The reverse gear control also operates pneumatically. The temperatures and oil pressures of Diesel engines and hydraulic transmissions are shown on gauges and tell-tale indicator lights are also fitted. The Diesel engine speeds are indicated electrically.

For the electric lighting each plant is provided with a dynamo and a 24 V battery. No other electrical equipment has been provided. Thus, the controls and electrical equipment are as simple as possible.

The ventilators for the cooling systems provided at each end are mechanically driven from the free shaft end of either Diesel engine. The power is transmitted via an elastic coupling on to an auxiliary transmission gear driving the cooler fan by means of a turbo regulating coupling. Due to the effect of a thermostat actuated by the engine cooling water, the turbo-coupling regulates the speed of the fan in such a way that the cooling water temperature is kept constant. The regulator has been arranged in such a way that in case of need, the maximum ventilator speed and hence the maximum cooling effect will be obtained with engine speeds of about 800 RPM and will be maintained up to the maximum engine speed of 1000 RPM.

The various auxiliary drives, such as the compressor for the compressed air brake, the vacuum pump for the train brake, and the lighting dynamo, are driven either from the step-up gear or partly from the ventilator gear by means of vee-belts.

The main frame, the bogie frames and the superstructure are electrically welded. The bogies are interchangeable.

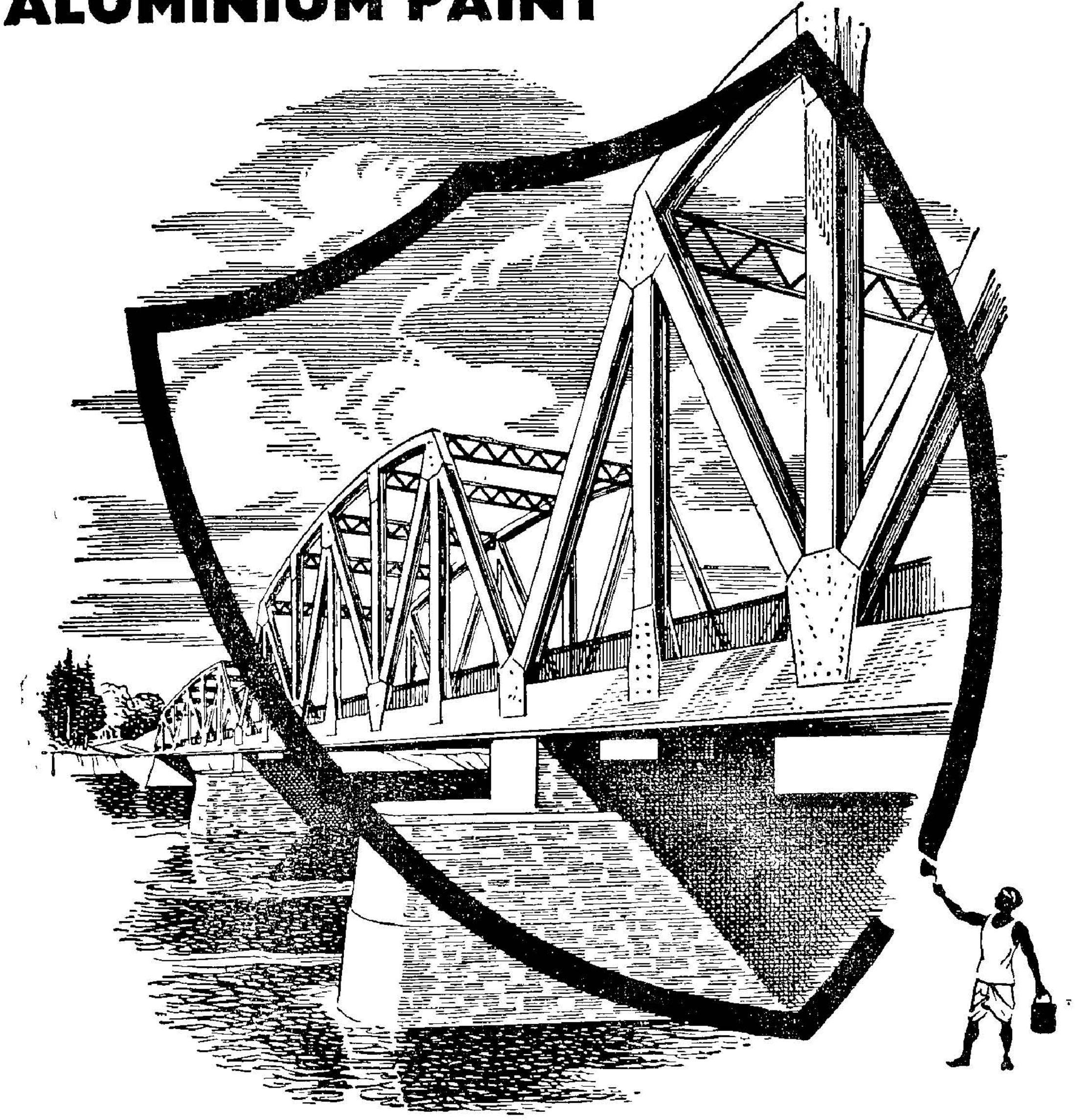
The locomotive is designed to carry the following:

fuel	880 Gallons (imp. Gallon)
Lubricating oil	44 Gallons
cooling water	132 Gallons

thus enabling it to run long distances without refuelling or taking on water.

(By courtesy The Indian Railway Engineer, Bombay.)

ALUMINIUM PAINT



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Application should be made to the Station Master of your starting station at least 3 days in advance specifying the date and train by which you intend travelling and the tickets must be bought in advance. The reservation fee leviable is 8 annas per seat or berth.

Reservation by I and II Class from intermediate stations by Express trains can also be made similarly, but reservation ticket can be issued only after getting an advice from the Reservation Centre that the reservation has been made.

Tickets will be issued only if accommodation is available.

If the reserved seats or berths are not occupied at least 5 minutes before the booked departure of the train the reservation will be cancelled and the seat or berth given away to another.

Reservation fee is not refundable.

III Class seats are also reservable on Express and certain other important trains for long distance passengers from the train-starting stations on payment of a reservation fee of four annas per seat.

Do not occupy a berth or seat reserved for another, as you are liable to be displaced at the last moment.

If you find another person occupying the berth or seat reserved for you and if he will not vacate it on demand, report it to the Guard or Station Master. They will help you.

(Inserted in the interests of Travelling Public by the Public Relations Officer, Southern Railways Magazine)

CLEANLINESS LEADS TO HEALTH AND HAPPINESS

Clean orderly habits contribute to general health and welfare and as such to happiness and prosperity; they are more important than medicines.

Cleanliness prevents disease; medicine only attempts to cure.

Cleanliness of the person, of the houses and colonies, reflects discipline in the individual and the community. Discipline is the foundation stone for progress of oneself and the country. Cleanliness is a good habit. It is also cheap.

All Railwaymen should set an example of cleanliness. This will help others and themselves.

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